SMPTE 2110 diagnostic and monitoring in real-time encoding systems

Jovo Miskin, Synamedia

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SDI vs IP

SDI

- Common infrastructure, uni-directional and simple
- Low latency, perfect synchronization
- Very reliable, almost never drops a frame
- 3G/12G … more coaxial cable

IP

- 10/25GbE to 400Gbe
- Uses COTS IT infra
- Cutting edge technology
- Pool of talent
- **IP is the future**

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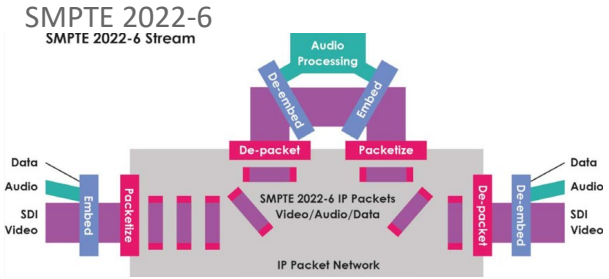
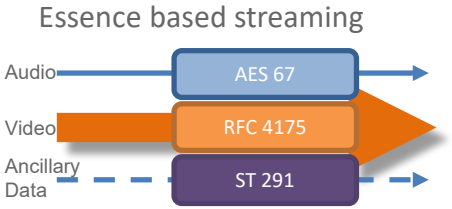
SMPTE 2022-6, SMPTE 2110

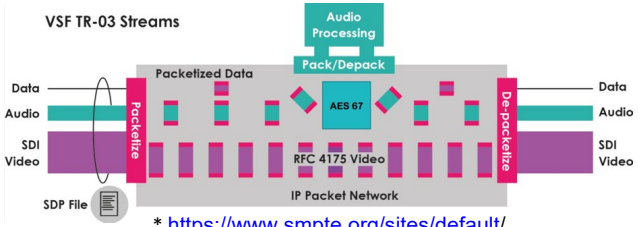
SMPTE 2022-6



* https://www.smpte.org/sites/default/...

SMPTE 2110





* https://www.smpte.org/sites/default/...

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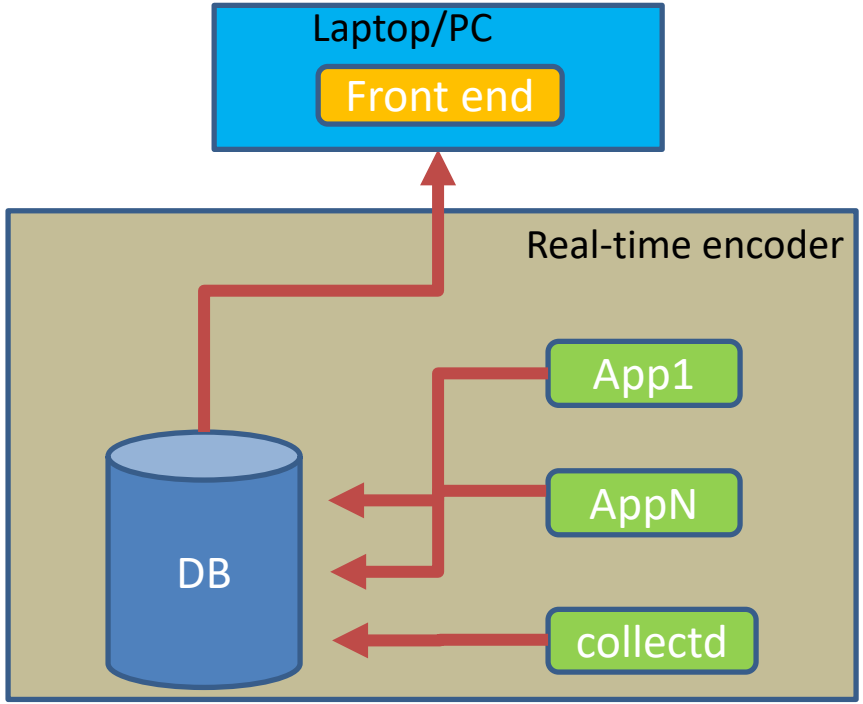
Why diagnostics & monitoring?

- Customers are accustomed to reliability of SDI
- When an error is reported, want to have means to trace it and identify a root cause. Point to or rule out inputs
- Need tools to monitor processing stages at various points of interest: leverage OS tools to accomplish this task
- Focus on SMPTE 2110 input processing: pure s/w, no kernel bypass or special NICs (Mellanox, Matrox, …)
- SMPTE 2110 + encoding at scale == challenge

Metrics Framework



- Open Source: InfluxDB, Grafana
- InfluxDB: GO, time series data, HA, performance.
  - System, apps
- Grafana: visualizes time series data

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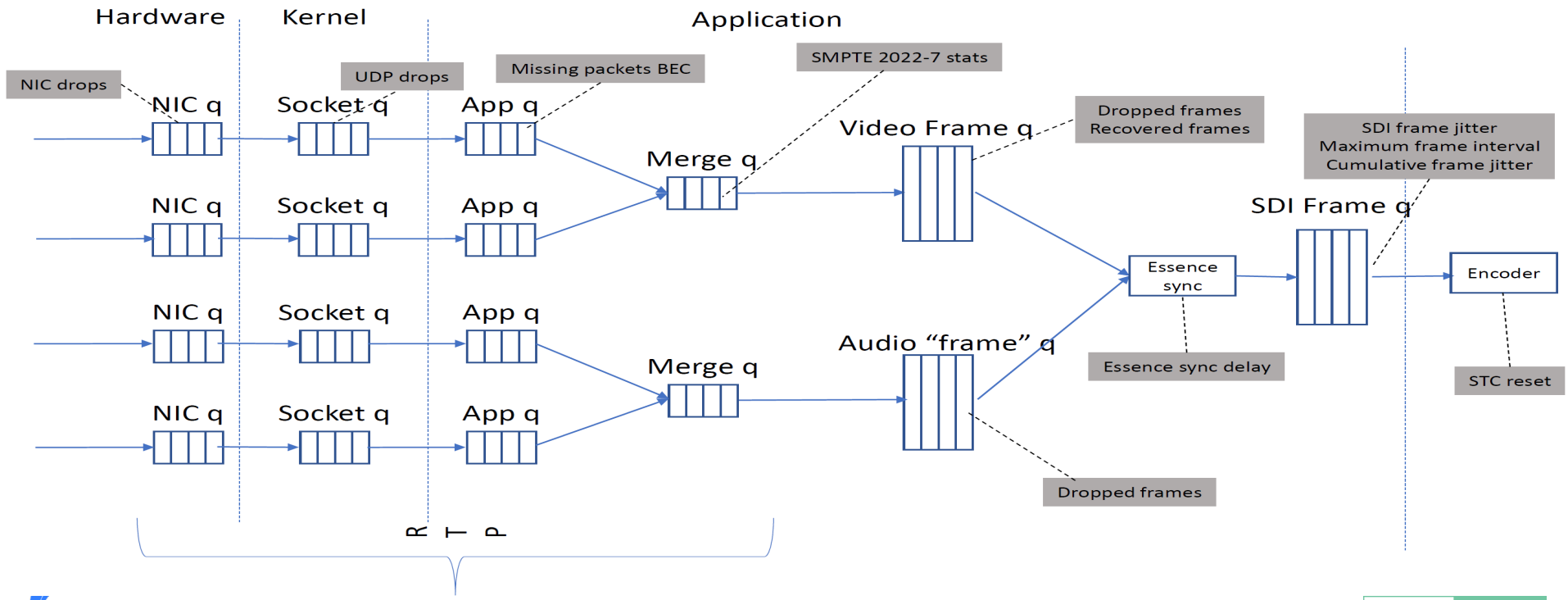
Packet Flow



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Metrics Categories

- Common
- Essence: video, audio, ancillary data
- SDI frame
- Resiliency / SMPTE 2022-7

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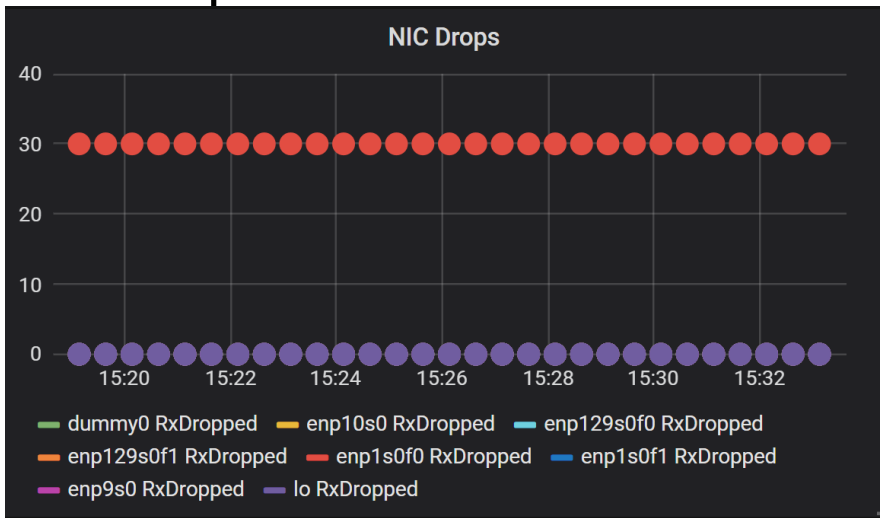
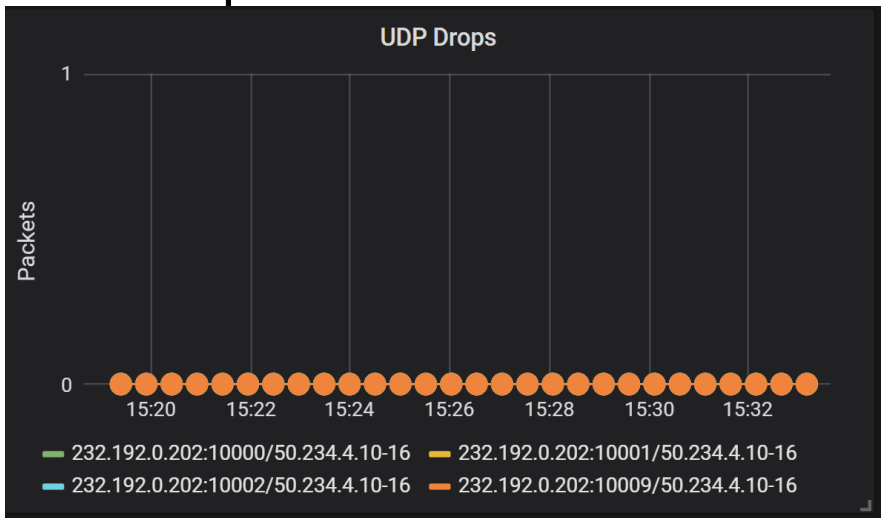
Common Metrics

NIC drops



Count of packets dropped by NIC. Per i/f.

UDP drops



Count of packets dropped by UDP socket.
Per RTP Stream

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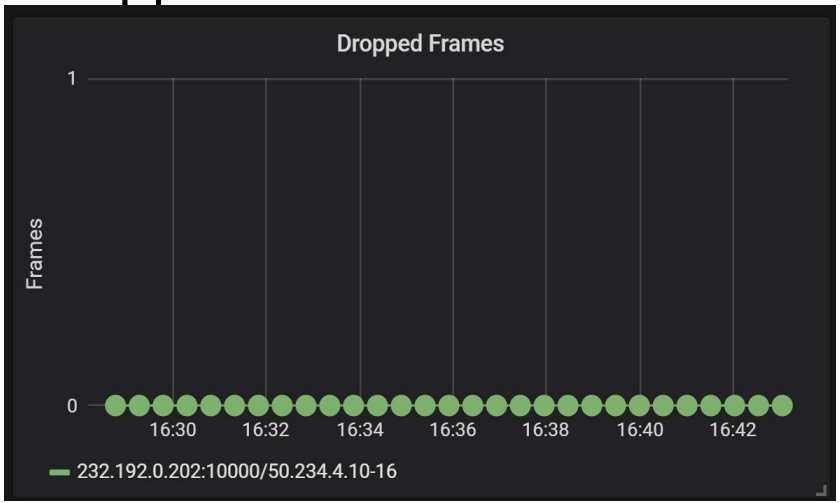
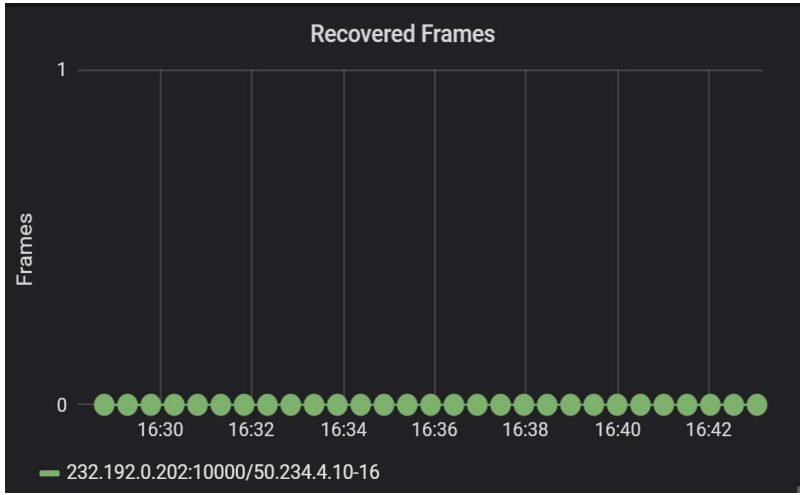
Video Metrics

Dropped frames



Count of the number of dropped video frames due to “Queue Full”

Recovered frames



Count of the number of Recovered video frames due to missing RTP packets.

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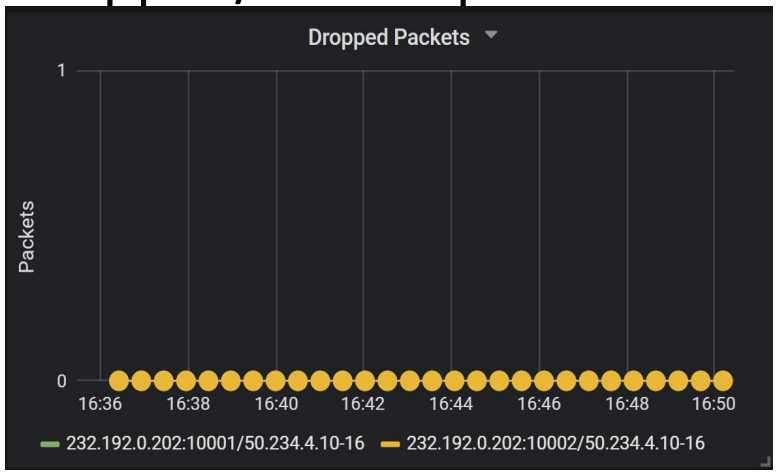
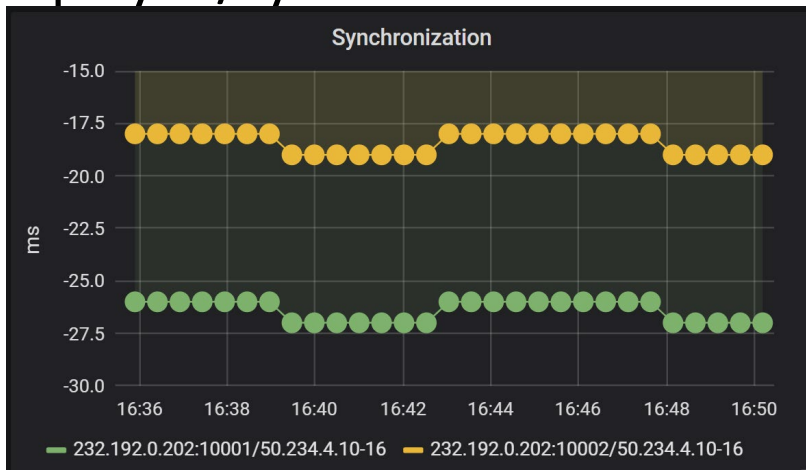
Audio Metrics

Dropped/missed packets



Count of the number of dropped/missed audio packets: early/late

Lip-sync/synchronization



Audio essence delay (ms) relative to video. Audio behind.

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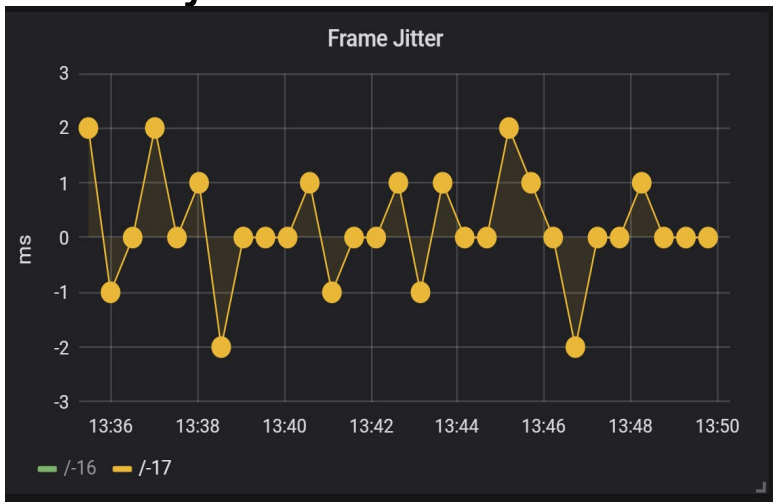
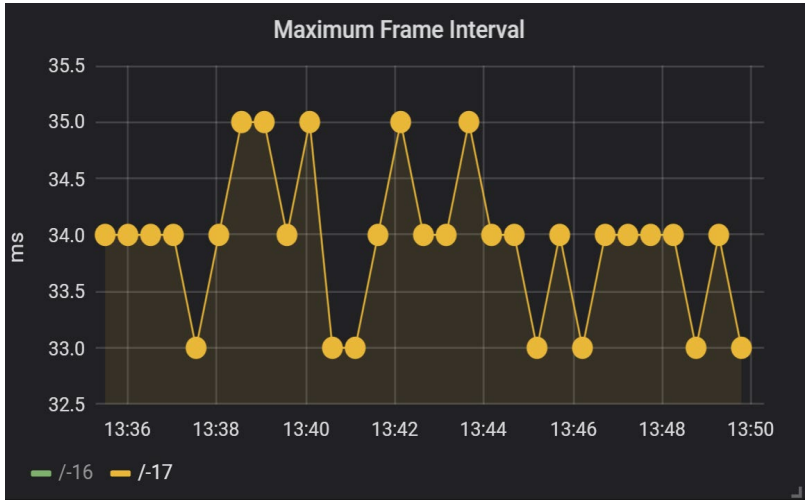
SDI Frame Metrics (1)

Frame jitter



Frame jitter relative to ideal frame timing

Maximum frame interval



Maximum frame interval within polling period

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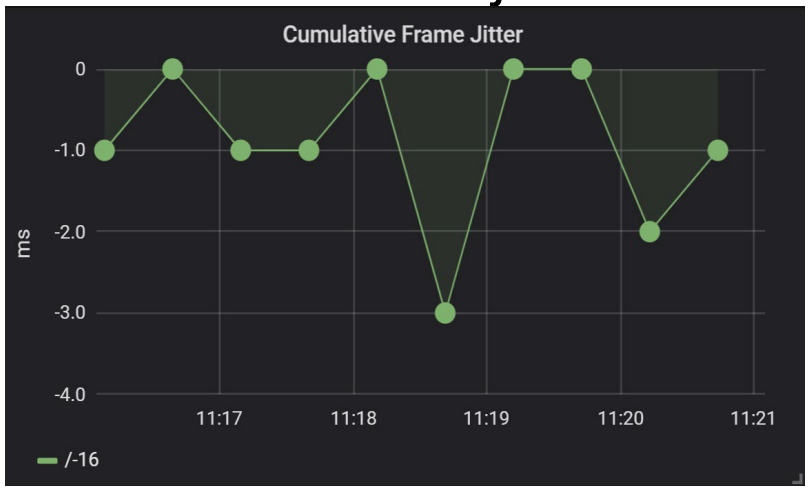
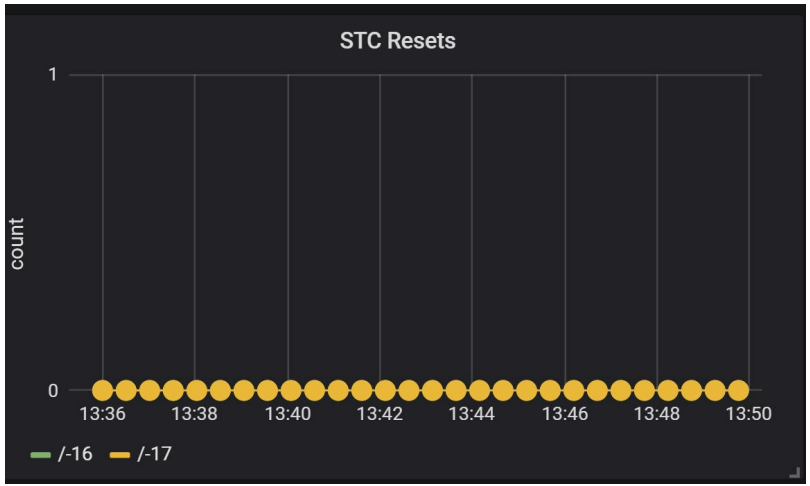
SDI Frame Metrics (2)

Cumulative frame jitter



Cumulative SDI frame jitter

STC resets



Count of clock resets due to reaching jitter threshold

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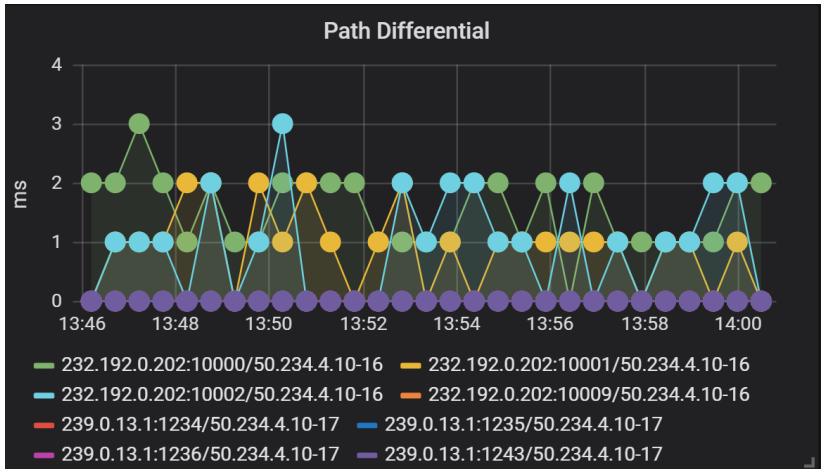
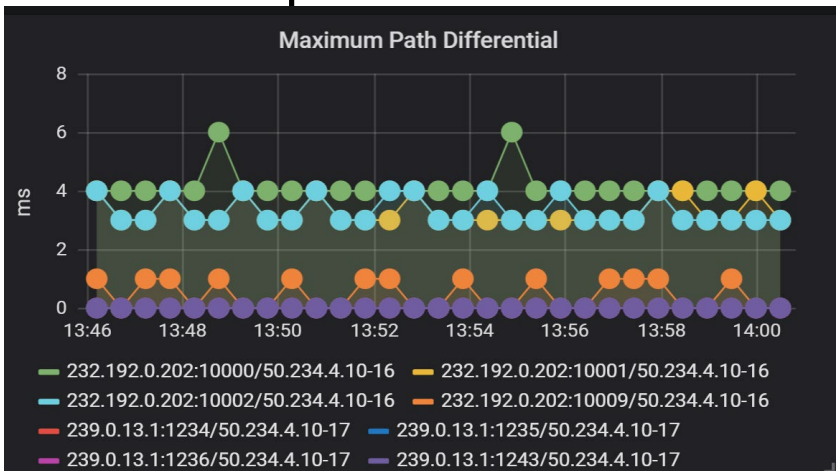
SMPTE 2022-7:Path Differential

Path differential



Instantaneous path differential

Maximum path differential



Maximum path differential within poling period

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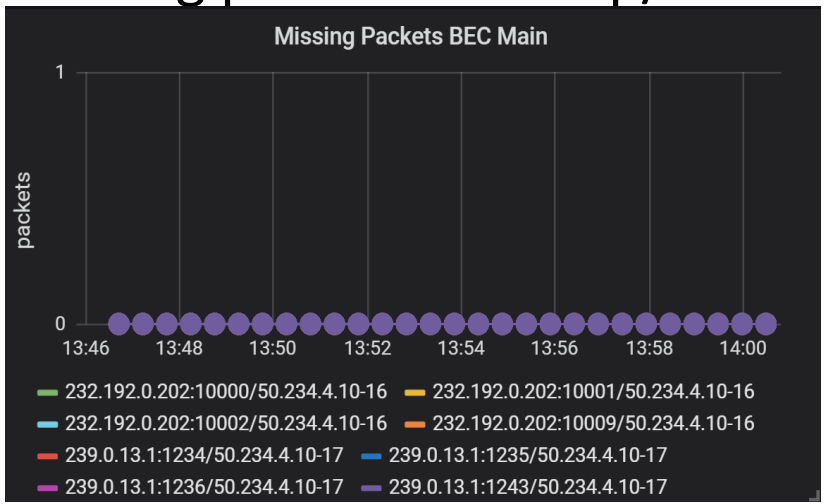
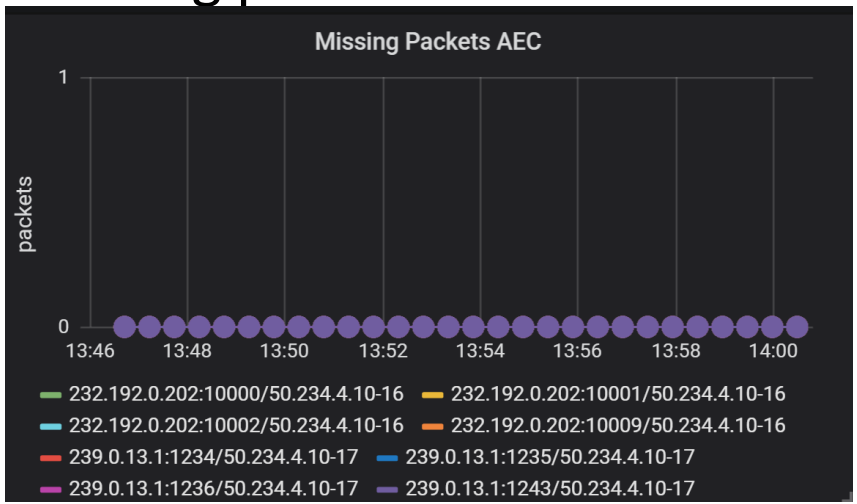
SMPTE 2022-7: Missing Packets

Missing packets BEC Bkp/Main



Count of the number of missing RTP packets on one path before error correction

Missing packets AEC



Count of the number of missing RTP packets on second path before error correction

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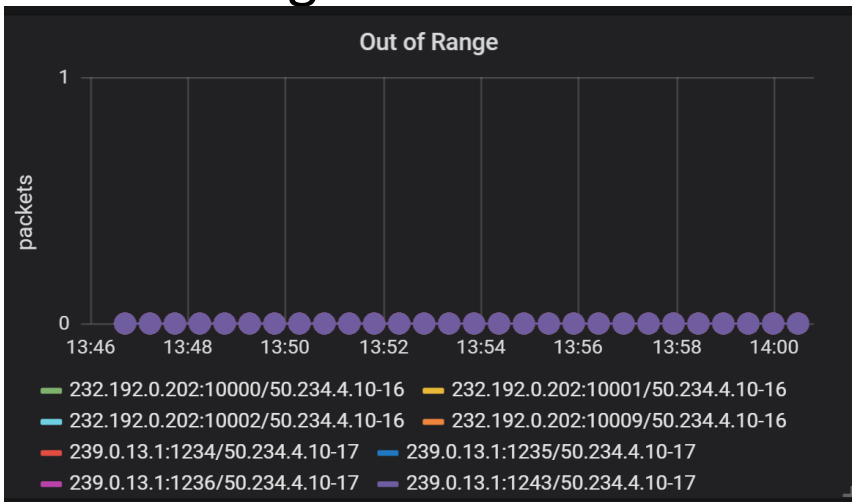
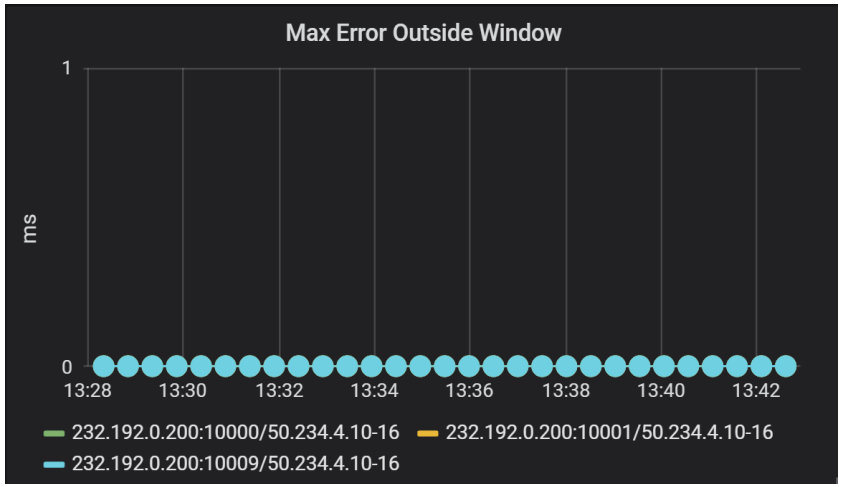
SMPTE 2022-7: Playout Window

Out of range



Count of the number of packets arriving outside playout window

Max err outside window



Maximum error (ms) when outside of playout window

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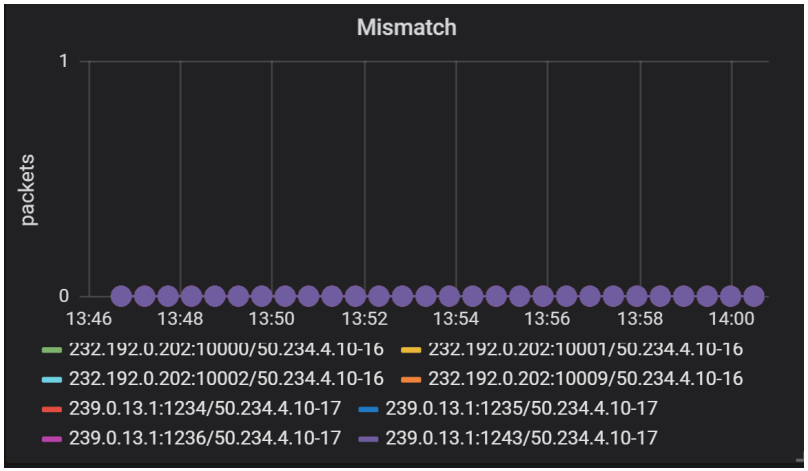
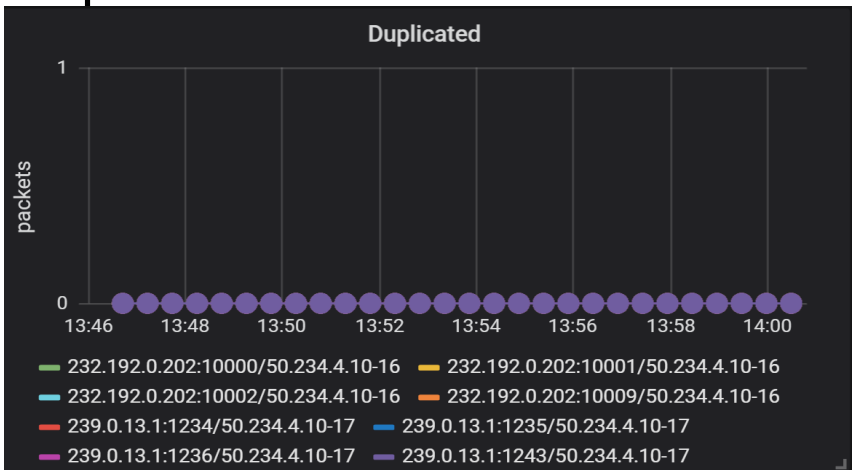
SMPTE 2022-7:Errors

Mismatch



Count of the number of mis-matched packets between two paths

Duplicated



Count of the number of duplicated packets on both paths

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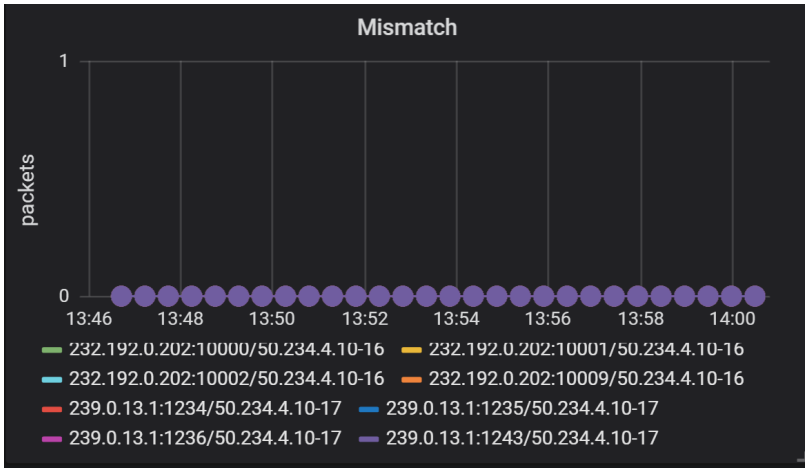
SMPTE 2022-7:Reordered

Reordered



Count of the number of reordered packets on both paths

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Use Case Analysis

- Encoder is reporting an alarm: Hitless Merge Redundancy Lost
- Above error means that one of SMPTE 2022-7 delivery paths is compromised – packets not received
- **How do we trace it to identify the root cause of this condition?**

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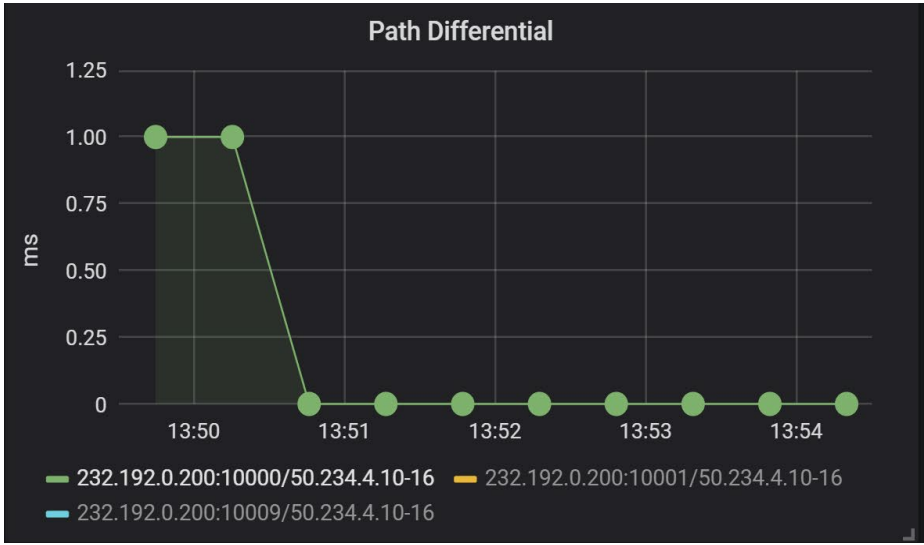
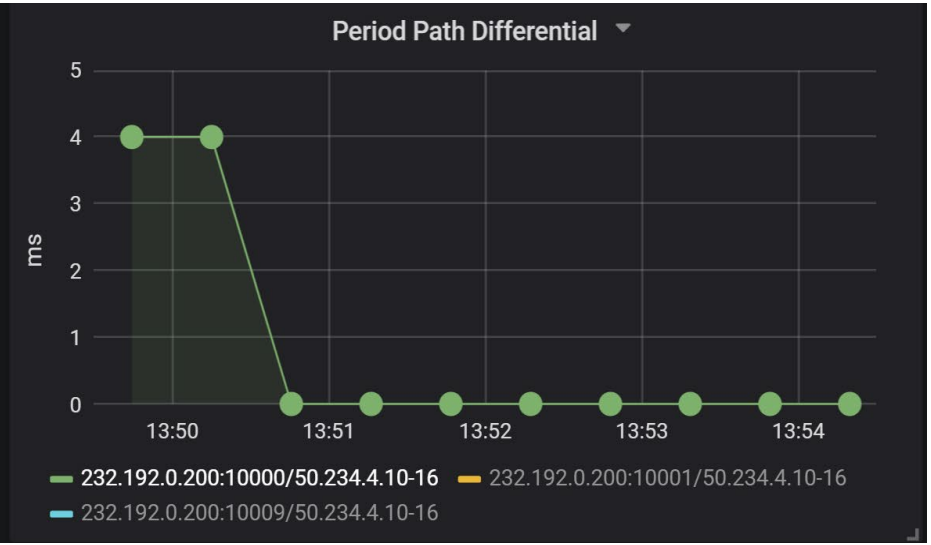
Use Case Analysis: step 1

Path differentials jumping to 0 is suspicious: not receiving or dropping packets?





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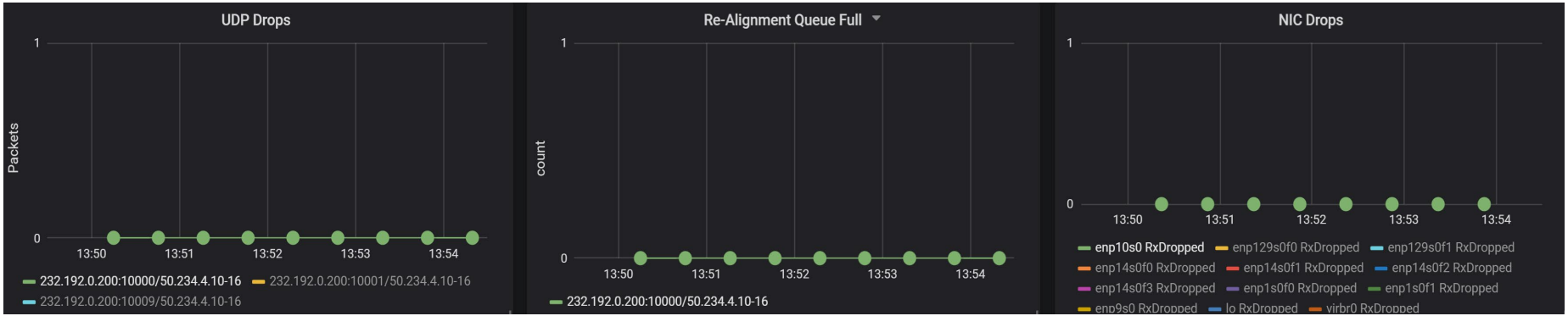
Use Case Analysis: step 2

Packets dropped?



No, that is not the case, no NIC or UDP drops, no Queue Full.

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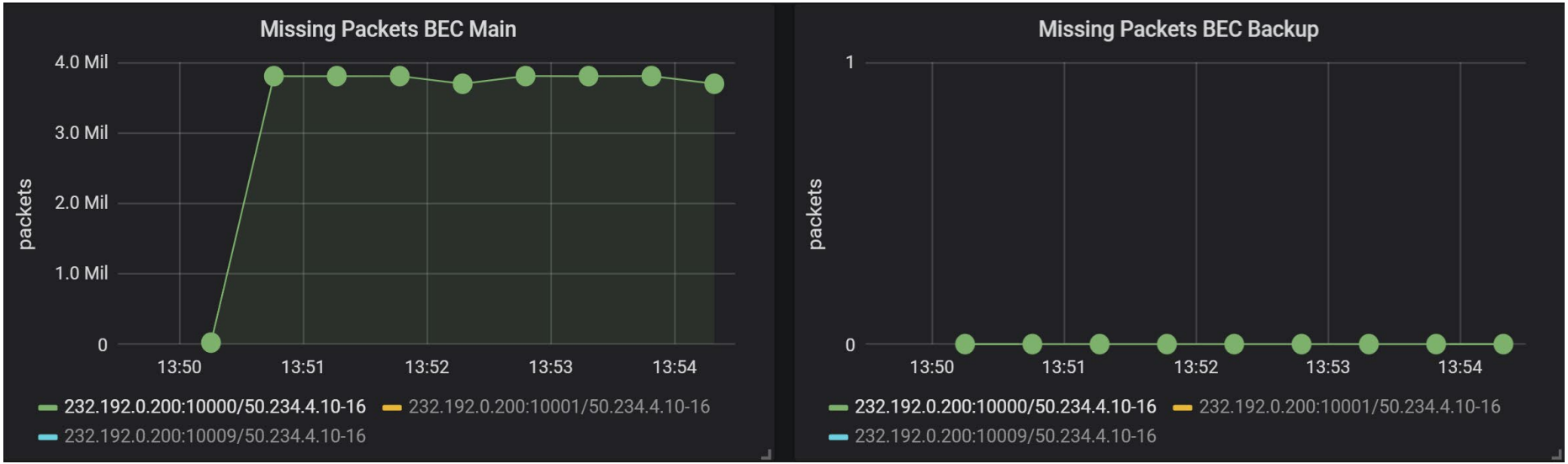
Use Case Analysis: step 3

Let’s check packet reception



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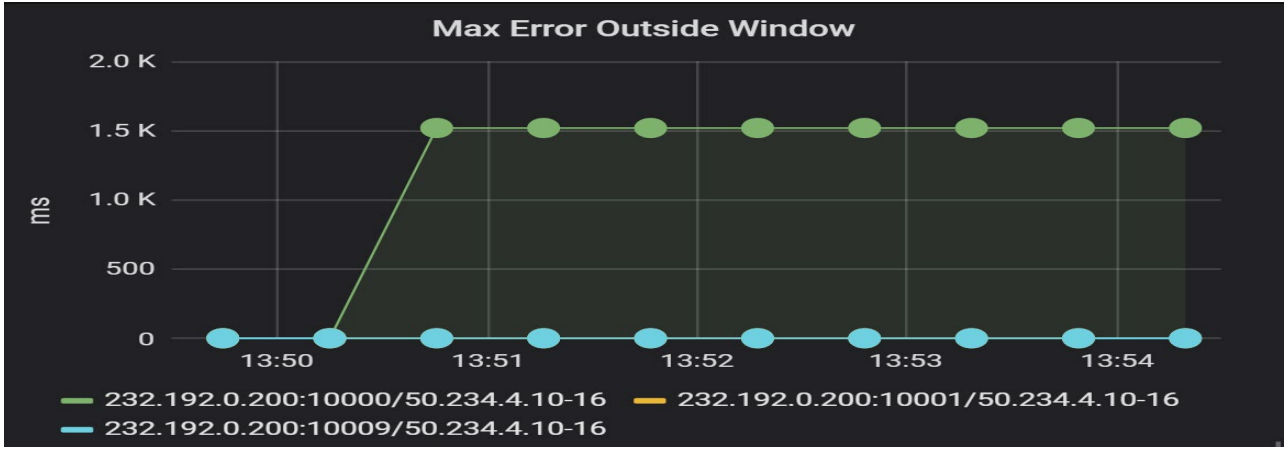
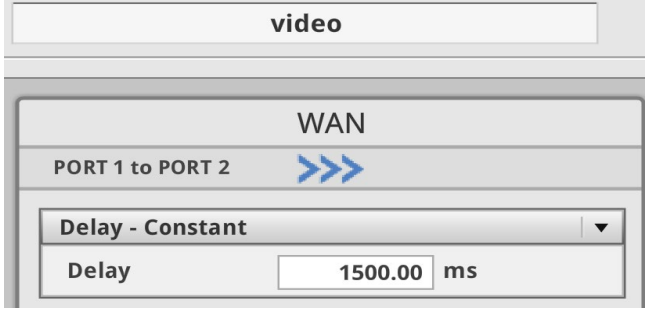
Use Case Analysis: step 4

Packets are arriving late, delayed on the network?



Indeed, the main path is delayed by 1500ms which falls outside of 100 ms playout window.



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Summary

- Other metrics are available: CPU load, memory, hardware monitoring, TS, codec throttling
- A simple approach of maintaining various counters and building monitoring framework around open source tools is very valuable in monitoring the health of ST2110 input streams
- Adequate monitoring granularity enables easy tracing to root cause of failure
- ***Strong metrics save time, effort and money***

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Q & A

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